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REPORT OF THE OFFICIAL DUTY TRIAL OF THE DE LAVAL PUMPING UNIT AT THE JOHN STREET STATION OF THE TORONTO WATER WORKS.

By Professor Robert W. Angus, '94.

Description of the Machine.

The unit consists of a 1,400 H.P. steam turbine, designed for a speed of 3,600 revolutions per minute and a steam pressure of 150 pounds. It is connected by gears with two centrifugal pumps so that the latter run at 600 revolutions per minute, the gears having a speed ratio of 6 to 1. The whole unit was built by the DeLaval Steam Turbine Company, Trenton, New Jersey, and furnished to the City by the Turbine Equipment Company, Toronto.

The Turbine.

The turbine is of the compound impulse type, built on similar lines to the Rateau and other machines of the same principle. The following details are taken from the general drawing furnished the City by the builders, only a few of the outside dimensions being checked.

The steam supply to the turbine is 6 inch diameter and passes through a Schutte steam operated trip throttle valve, thence through the governor direct to the steam chest of the turbine, from which it enters the turbine nozzles. The governor is of the John's type, and acts on a pilot valve, which in turn admits steam to a piston controlling the governor valve, the latter being a balanced double seated valve; the control of the turbine is by throttling.

In addition to the main governor, an emergency governor is connected with the Schutte trip valve already mentioned, which trips and closes the steam off when the turbine speed reaches 3,840 revolutions per minute.

The turbine has 14 wheels of blades in two groups, the first one consisting of five wheels and the second and larger group, of nine wheels with a small receiver space between the groups. The wheels in the smaller group have a mean diameter of approximately 6 inches less at the centre of the blades than the corresponding wheels in the larger group.

Where the shaft passes through the casing of the turbine, the gland is packed with carbon rings and also sealed with steam at 6 pounds pressure; the condensation from these glands being drained away. The rotor is carried on two bearings, these bearings being entirely free of the turbine casing and being carried on the bed plate of the machine. A small thrust bearing on the rotor shaft takes up any unbalanced end thrust, and the governor and oil pump are driven from this main shaft by worm and gear.

The turbine exhaust pipe is 36 inches diameter where it leaves the turbine and enters the condenser. The condenser, which was made by the C. H. Wheeler Manufacturing Company, Philadelphia, is of the water works surface type having a condensing surface of 1,500 square feet made up of 1-inch brass tubes 7 feet 2 inches long, the inside diameter of the shell being 6 feet. All of the water passing through the main pumps also pases through the condenser, the main suction passing through it. The diameter of the suction main entering the condenser is 42 inches, and that leaving it is 36 inches, while the air pump suction connection is 8 inches diameter.

The air pump is a Mullen patent wet vacuum pump built by the C. H. Wheeler Manufacturing Company, steam cylinder 8 inches diameter, pump cylinder 16 inches diameter, stroke of both pistons 12 inches. The steam end of the machine is of the ordinary slide valve type controlled by a throttling governor. The vacuum cylinder is of cast iron with a hard brass cylinder liner, and a long piston so adjusted as to open the inlet parts in the cylinder when it passes over them, the action being similar to that in two cycle double acting gas engines. The steam and pump pistons are coupled together and the stroke is governed by a crank with fly wheel.

The valve deck plates are bolted to the ends of the pump barrel and hold Gutermuth valves opening outward only, i.e., water and air are admitted to the cylinder when the piston uncovers the central port by moving past it, and then the delivery to the hotwell takes place through the valves on the deck plates. The Gutermuth valve is a coiled flexible bronze spring.

Steam for driving the air pump is taken from the main supply pipe between the separator and the steam turbine, and the exhaust from the pump passes through a steam trap and into the turbine itself where it is utilized in doing work. There was no means of obtaining during the test, the air pump exhaust pressure. The drip from the trap on the air pump exhaust passes through an oil trap and the oil is drawn off. No oil reached the inside of the turbine, and the exhaust steam from it was perfectly clean.

The speed of the air pump was about 116 revs. per minute.

The condensed steam passes into the hot well, from which it is delivered to the boilers by a Goulds triplex single-acting boiler feed pump driven by chain from the main pumping unit. Each of the three plungers is 3½ inches diameter and 6 inch stroke, and the speed is approximately 45 revolutions per minute. Owing to the great amount of condensing water and the high vacuum, the temperature of the feed water was quite low.

Returning again to the main turbine, the drive from it to the pumps is made by means of double helical gears having a speed ratio of 6 to 1 thus giving a pump speed of 600 revolutions per minute at the normal turbine speed of 3,600 revolutions per minute. The two pinions are far enough apart to place a bearing between and thus the pinion shaft has three bearings and the shaft itself is connected to the turbine shaft by a flexible coupling. The same thing applies to the gears which are connected to the pump by a flexible coupling.

The main turbine bearings and also the pinion bearings and the gears themselves are oiled by a gravity system. An oil pump is attached below the governor and the oil drains away from the bearings to the pump and is then lifted into an overhead tank, from which it runs by gravity to the bearings. The oil itself is water cooled on its way to the overhead tank and water cooling is also used on the pinion shaft bearings. The large gear bearings are ring oiling.

The pumps consist of two separate duplicate pumps connected together by piping, the shafts of both pumps being connected by flexible couplings and being in line with the large gear shafts. In this place it may be explained that the whole machine consists of four distinct units connected by flexible couplings, viz.:—the turbine, the gears with their shafts, the first pump and the second pump.

Each pump is of the single stage, double entry centrifugal type, i.e., without outside guide vanes, and has a volute casing. The inlet and outlet are each 24 inches diameter and the two ring oiling bearings on each pump are bolted to the sides of the casing. The pumps run in series, the discharge from the first pump being carried to the suction of the second by piping under the floor. The stuffing boxes are sealed by water from the pumps themselves and priming is arranged by means of a single steam ejector connected to the top of each pump casing. The impellers are of bronze.

Nominal Dimensions of the Pumping Unit.

The dimensions set down here are largely those given by the builders, and were not verified, as they were not essential to the duty trial, and are given for the sake of information only.

Steam Turbine.

Type of turbine—Compound impulse.

Speed, revolutions per minute	3,600

Saturated steam pressure, pounds per square inch	150
Rated horse power	1,400
Number of blade wheels	14
Number of main bearings	2
Size of steam pipe, inches	6
Size of exhaust pipe, inches	36

Condenser.

Water works—Surface type.

Diameter inside of shell, feet	6
Size of tubes, inches	1
Length of tubes, inches	86
Condensing surface, square feet	1,500
Suction pipe entering condenser, inches	42
Suction pipe leaving condenser, inches	36
Steam inlet, inches	36
Outlet to air pump, inches	8

Air Pump.

Type—Steam driven, crank and flywheel vacuum pump, wet service.

Diameter steam cylinder, inches	8
Diameter pump cylinder, inches	16
Stroke of both cylinders, inches	12
Speed, revolutions per minute	116

Boiler Feed Pump.

Type—Belt driven, triplex, single acting.

Number of plungers	3
Diameter of plungers, inches	3½
Stroke of plungers, inches	6
Speed, revolutions per minute	45

Driven by silent chain from main turbine shaft.

Venturi Meter.

Diameter at each end, inches	30
Diameter at throat, inches	15

THE DUTY TRIAL.

General Conditions Governing the Trial.

The pumping unit was brought under the general specifications dated October, 1912, and these specifications provided for prices being submitted on three different machines, viz.:—(a) a self contained vertical, triple expansion, fly wheel, plunger pumping engine with jacketed steam cylinders; (b) a centrifugal pump driven by a triple expansion condensing engine running at a speed of not over 350 revolutions per minute and designated as "Alternative No. 1", and (c) a centrifugal pump driven by steam turbine, the speed of the pump not to exceed 750 revolutions per minute. This is marked "Alternative No. 2".

The capacity of the pumps as shown by Section 5 of the specifications in each case was to be "not less than 15 million Imperial gallons of water in 24 hours, against a pressure difference of 105 pounds per square inch between the suction and discharge mains, the pressures to be measured at approximately the same level".

The pump purchased was that specified under "Alternative No. 2" consisting of pumps driven by a steam turbine as described in the early part of this report. Under Section 78 the conditions for testing the pump are as follows:— "Paragraph 73 relating to 'Tests' in Alternative No. 1 to apply to Alternative No. 2 with this exception: should the contractors guarantee a duty in excess of 100,000,000 foot pounds when using saturated steam, the duty guaranteed will be substituted for this amount, and for each one million (1,000,000) foot pounds in excess of the guarantee, the Corporation shall pay to the Contractor the sum of fifteen hundred dollars ($1,500) and pro rata for fractional parts, but the total bonus shall not exceed ten thousand dollars ($10,000). Should the duty . . . . . be less than the guarantee the Commissioner shall deduct . . . . . two thousand dollars ($2,000) for each million (1,000,000) foot pounds unperformed . . . . . . ". "If the duty be more than five million foot pounds below the guaranteed duty, the Commissioner may . . . . . . reject the unit."

Section 73 says:—

"This unit shall perform a duty of not less than one hundred million foot pounds for each one thousand pounds of steam, containing not more than 1½ per cent. of entrained water as determined by throttling calorimeter measurements, used by engine, and any auxiliary pumps supplied by the contractor and operating during the duty trials, when pumping not less than 15,000,000 gallons per 24 hours as per pressure, suction and speed specified.

In computing the duty the work performed shall be based upon Venturi meter measurements, and the head shall be shown by an accurate pressure gauge, attached to the discharge main (see Section 70).

All the steam used by jackets, reheaters, air pumps, air compressors, boiler feed pumps, and other auxiliaries, required for the operation of the unit, shall be charged up to the engine in computing the duty."

The conditions of the trial are further governed by Section 75 which says:—

"After the pump has been in successful operation for sixty days, a duty trial of 24 hours' duration shall be made.

The pump shall be operated continuously at its rated capacity, against a pressure of 106 pounds, as recoiding on the gauge. (See Section 70 for location of gauge.)

Engine to be supplied with steam at 150 pounds gauge pressure at the boilers."

Section 70 states in part:—

"The head for computing the duty shall be that shown by an accurate pressure gauge attached to the discharge main at a point inside the engine room and beyond the last pump, less the reading shown by a gauge attached to the supply conduit at or near entrance to pumps, an allowance being made for any difference in the level of the gauges. No allowance shall be made for friction of water between the gauge points, between which shall be situated the complete machine as supplied by the contractor.

"In computing the duty, the total steam used including that used by jackets, reheaters, air pumps, air compressor, bolier feed pump and any other auxiliary pumps? shall be charged up to the engine.

"The duty trial shall be of 24 hours' duration. The engine shall be operated continuously at its rated capacity, against a pressure difference of 105 pounds per square inch as above specified, and shall be supplied with steam of not more than 150 pounds per square inch by gauge at the boiler.

"During the trial the engine shall be operated by the regular engineers of the Station, at the speed and pressures specified, but otherwise shall be under the control of the contractor. The trial shall be conducted by the Commissioner, or person appointed by him, in the presence of a representative of the contractor."

After the specifications had been printed some correspondence took place between the Commissioner of Works and the contractors, The Turbine Equipment Company of Toronto, and on March 18th, 1913, the Commissioner wrote the contractors as follows:—

"Replying to your favor of the 13th inst., I beg to advise you that, as arranged, the official test on the turbine pump you are building for us will be made against a pressure difference of 115 pounds per square inch, while delivering about 15.5 million Imperial gallons."

The Turbine Equipment Company further stated that their pump would satisfy the City specifications in regard to quantity and pressure at a speed of 600 revolutions per minute.

In a turbine pump design it is not possible to decide in advance on the corresponding pressure, discharge and speed, and only two of these qualities can be definitely fixed and the pump designed to approximate to the third one as nearly as possible. In the present instance, at a speed of 600 revolutions per minute and a pressure difference of 115 pounds per square inch, the discharge considerably exceeded the specified quantity of 15.5 million Imperial gallons per 24 hours. In running the test, therefore, it was decided to adhere as closely as possible to the desired speed of 600 revolutions per minute and pressure difference of 115 pounds per square inch, and take the discharge as it actually occurred.

Steam Pressure.

The specifications required a gauge pressure of 150 pounds per square inch at the boiler. During the time the test was run, very extensive changes were taking place at the pumping station; a new boiler room was being constructed and some of the old buildings had been removed, so that the steam pipe to the turbine from the boilers was very long and a greater part of its length was exposed to the weather. Under such conditions it seemed unfair to adhere to this pressure at the boiler, but to make allowance for losses which would occur under fair normal conditions it was decided to carry 149 pounds per square inch at the turbine throttle. The record shows, however, that the actual pressure was somewhat lower than this. The pressure above the turbine nozzles was read on a gauge.

Quality of Steam.

The steam to be supplied was to contain not more than 1½ per cent. of entrained water as determined by throttling calorimeter measurements. The throttling calorimeter was attached to the main steam supply pipe just a few inches on the boiler side of the throttle valve. The steam separator between the turbine and the boiler worked very efficintly and the steam as measured contained only 1.05 per cent. of moisture. The pressure in the calorimeter was taken on a mercury manometer.

Vacuum.

The vacuum on the turbine was measured by means of a mercury column attached thereto.

Water Pressures.

In measuring the water pressures, the suction pressure was determined by means of a glass tube open at the top and attached to a flexible rubber hose which was connected to the suction pipe inside the engine room and within a few feet of where the water entered the condenser. The height of water in this tube above the concrete floor is called the suction pressure, the water in it always stood above the centre of the suction pipe.

The discharge gauge was attached at the discharge flange of the pump where the diameter of the pipe is 24 inches.

An accurate gauge was used, reading to ½ pound per square inch. The elevation of the centre of the discharge gauge above the datum used on the suction pressure was 13 feet.

The total pressure was found by adding the pressure equivalent of 13 feet to the discharge pressure and subtracting therefrom the suction pressure reading reduced to pounds per square inch.

Capacity of the Pump.

The capacity of the pump was determined by means of a Venturi meter, as required by the specifications. In order to eliminate any possible error from the recording mechanism, a mercury manometer was connected up so as to record the exact difference of pressure in the tube, readings on this manometer being used to compute the discharge.

The co-efficient used for the Venturi tube was that obtained from the scale furnished by the makers, The Builders Iron Foundry. The meter was 30 inches diameter at the ends, with a 15 inch throat.

Barometer.

The barometric pressure during the test was obtained from the records of the Meteorological Office on Bloor Street, a correction being made to allow for difference of level between the Observatory and the John Street Station. Both days of the test were very unpleasant, with very heavy rain on Monday and a very dense fog, for Toronto, on Tuesday. The barometer, however, stood quite high, the corrected reading for the John Street Station being 29.88 inches.

Condensed Steam.

The exhaust steam from the turbine, which included that from the air pump, was delivered by the air pump into a reservoir in the basement of the engine room. This reservoir had a quick-opening valve, by means of which the condensed steam could be delivered into a weighing tank on scales and there weighed.

The drips from the governor valve and glands, as well as the water from the separator attached to the exhaust pipe of the air pump, were collected in a barrel partly filled with cold water and weighed, the water being run out and fresh cold water introduced whenever the water in the barrel became hot.

Observers and Observations.

Observations were made by students in the fourth year in the Faculty of Engineering of the University of Toronto. These men were all skilled in such work, which forms a large part of their daily duties. They were divided into three shifts of about eight hours each, each shift overlapping the previous one by about one hour.

Observations were taken at regular intervals during the entire trial, those on the suction and discharge pressures the Venturi meter and the weight of condensed steam being taken every 7½ minutes, while those on the main steam and nozzle pressures, the vacuum, the speed and the calorimeter were taken at 15 minute intervals. The weight of steam from the drips was taken about every 45 minutes, but the intervals varied somewhat, as the weights were taken and cold water put into the barrel when necessary.

All gauges used were calibrated both immediately before and after the trial by a Crosby dead weight tester, and the scales were examined by the Government Inspector just before the trial and a certificate that they were accurate, was given by the Inspector.

During the entire trial the weight of condensed steam, along with the tank holding it, was very close to the capacity of the scales. Owing to an error of the observers in taking the time, the weight at 7.07½ exceeded the capacity of the scales and had to be estimated. In doing this the probable weight was estimated from the average of the previous six readings and would have an error not exceeding 40 pounds, which is negligible in comparison with the total weight of steam used in the trial of 370,280 pounds.

Representatives at the Trial.

The contractors were represented by their local and district Managers and by Mr. Waller, Chief Engineer of the DeLaval Company, the plant being in charge of the Chief Engineer of the station, Mr. McRae.

RESULTS OF DUTY TRIAL.

The results of the trial are given herewith.

General.

Date of trial, 3 p.m. Monday, November 30th to 3 p.m Tuesday, December 1st.

Duration of trial, hours	24

Corrected Average Pressures.

At turbine in main steam pipe, pounds per sq. in.	148.0
At turbine nozzles, pounds per sq. in.	137.4
Vacuum, inches of mercury	28.82
Barometer, inches of mercury	29.88

In discharge main at exit from pump, pounds per sq. in.	111.82
In suction main before entry to condenser, feet above datum	5.72
Elevation of discharge gauge above datum, feet	13.0
Pressure difference on pump, pounds per sq. in.	114.10
Pressure differences specified, pounds per sq. in.	115

Average Temperatures.

Of engine room, Fahrenheit	69.
Absolute pressure in condenser, inches of mercury	1.06
Corresponding temperature, degrees Fahrenheit	81.

Calorimeter.

Pressure of supply steam at calorimeter, pounds per sq. in.	148.0
Pressure in calorimeter, inches mercury	2.51
pounds per sq. in.	5.1
Temperature in calorimeter, degrees Fahrenheit	297.2
Moisture in steam, per cent.	1.05
Moisture specified not to exceed, per cent.	1.50

Speed.

Speed of turbine, revolutions per minute	599.5

Water Pumped.

Difference in pressure by manometer between entrance and throat of Venturi meter, inches mercury	11.542
Water delivered, Imperial gallons per 24 hours	18,373,000

Steam Used by Turbine During Trial.

Steam condensed in condenser, pounds	369,331
Steam from glands, etc., pounds	949
Total steam used by turbine, pounds	370,280

Horse Power Developed.

Pressure difference on pump, pounds per sq. in.	114.10
Water pumped, Imperial gallons per minute	12,759
Water Horse Power	1,016.4
Steam per water horse power per hour, pounds	15.18

Duty.

Work done by pump in 24 hours, foot pounds	48,301,255,720
Steam used by pump in 24 hours, pounds	370,280

Duty per thousand pounds of steam used, foot pounds	130,449,000
Duty guaranteed, foot pounds	118,500,000

Respectively submitted,

ROBERT W. ANGUS.

Toronto, Dec. 28th, 1914.

It will be seen that the contractor sufficiently exceeded his guaranteed duty to gain the maximum bonus allowed.

VALVE DIAGRAMS AND THEIR APPLICATION

Part II.

By M. L. Smith, B.A. Sc., '11, Associate Editor,

" *The Power House.*"

In the last number the Bilgram valve diagram, in its simplest form, was explained at length. The application of all valve diagrams is modified by a number of conditions, such as angularity of the piston and eccentric rods, the manner of transmitting the motion from the eccentric to the valve stem, etc. The effect of all such considerations should be thought out before proceeding to obtain information by means of valve diagrams. The diagrams, as explained, apply to the plain slide valve and its simpler modifications. Its application to other valve gears will be explained as these are separately taken up.

Angularity of the Connecting Rod

The crank pin does not move back and forth in a straight line as does the piston and cross-head, but must swing round in a circle. For this reason the method of determining the crank pin position which has been given is correct only for such mechanisms as the slotted cross-head, Scotch yoke, and others in which the angularity of a connecting rod can have no effect. The swinging of the connecting rod from side to side, if the engine be running over, will cause cut off to occur earlier in the return stroke and later in the forward stroke, the piston being pulled forward in proportion to the amount of sideways motion of the crank pin.

If it be required to accurately find the relative positions of the crank and piston and thus the valve and piston, the effect of the connecting rod must be taken into account. This is done, as shown in Fig. 1, by means of the arc Cx instead of the straight line Cw, as in Fig. 2. The radius of this arc is equal to the length of the connecting rod to the same scale as the crank pin circle, and its centre is located on the base line extended towards the head end of the cylinder. The eccentric rod is usually very long in proportion to the valve travel, and, for this reason, the angularity of the eccentric rod has little effect on the valve, and can, therefore, in most cases be neglected.

Equalizing the Cut-off.

In order to have the cut-off occur at similar points in both forward and return strokes, various expedients are adopted. An examination of Fig. 3 will make it plain that if cut-off is to come about at similar points in the cylinder for both strokes, the crank pin positions will have to be different on account of both being drawn towards the cylinder. It is seen that one way of overcoming the effect of this shortening of the connecting rod would be to increase the lap for the head end and to decrease it for the crank end, as shown in Fig. 3. The drawback to this method is that the lead becomes excessive for the return stroke, as shown by the distance (a_1 q_1) as compared to (a q) which represents the lead for the forward stroke. The port opening is also unequal for all parts of the stroke, which is, however, not so important.

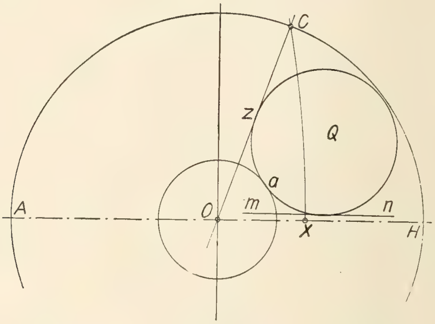


Fig. 1—Use of Bilgram Diagram to determine point of cut off.

A much better way of equalizing the cut-off is by means of a rocker arm, as shown in Fig. 4. The rocker arm, by creating similar irregularities in the valve motion serves to neutralize the effect of the connecting rod without disturbing the leads. Determine from the Bilgram diagram the travel, lap, angle of advance, etc., for one end, taking into account the effect of the connecting rod. Lay off the stroke, as at A H, and, upon it, the points where cut-off is to take place. On the same base line extended draw the crank pin circle C N and the valve travel circle (m n). Draw in the crank positions for cut-off—namely, C and N and for admission. Lay off the corresponding positions of the eccentric centre 90 degrees plus the angle of advance ahead of these. These are (n) and (m) for cut-off and (o) and (p) for admission.

We know that the valve is in the same position for both cut-off and admission—that is, for positions (o) and (n) and (p) and (m). Now, with the points (o) and (n) as centres, strike little arcs (o_1) and (n_1). Their intersection is the point

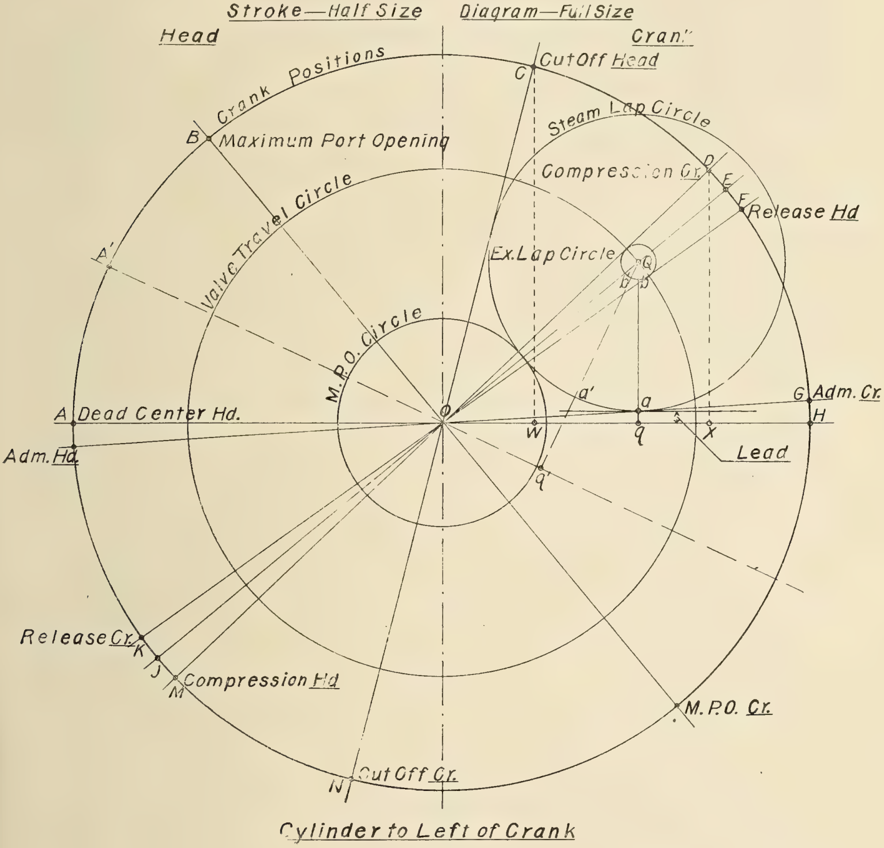


Fig. 2.—Complete Bilgram Diagram.

at which the eccentric rod pin should be for admission and cut-off on the forward stroke. In the same way the point where the arcs (m_1) and (p_1) cross will be the same pin position for the return stroke. Connect these two points with a straight line and from its centre draw a perpendicular, as shown. This line will represent the central position of one arm of the rocker. The other arm V W should be perpendicular to the valve stem at the central position, and the point of intersection W must be chosen so as to make the two lever arms proportional to the throw of the eccentric and the travel of the valve respectively. In a similar way release or compression may be equalized.

The equalization of the cut-off has more to do with the designing of the engine than with its operation; nevertheless a knowledge of the methods employed will be of great assistance in correcting troubles located by means of the steam engine indicator. Also, in attempting to obtain information by means of the Bilgram diagram care should be taken to find out previously whether means have been adopted to equalize the cut-off and other events of the stroke or not. It is well to observe also that where rocker arms are used, the throw of the eccentric is not necessarily the same as the valve displacement.

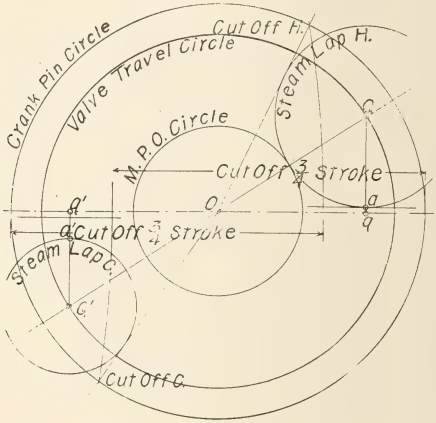


Fig. 3.—Effect of Angularity of Connecting Rod.

The Zeuner Diagram.

In a large number of shops in this country where the output of engines is not great, the setting of the eccentric is usually a cut-and-try process, and no diagram is used. When questioned concerning this practice the reason often given is that the purchaser sometimes has ideas of his own regarding amount of lap, lead, etc., and that no standard can be adopted. In the British Isles where the marine engines built are no doubt the best of their kind in the world, the valve gears are made to be assembled without any trial cuts so to speak, eccentric settings, laps and port widths being calculated beforehand by means of diagrams.

Among European engineers, the diagrams devised by Dr. Zeuner are most used and, for this reason, synopsis of their main features will be dealt with here. Many points of similarity will be found between the diagrams of Zeuner and Bilgram, and if either has been well understood by the student, no trouble should be experienced in mastering the salient points of the other.

The typical feature of the Zeuner diagram is that the value displacement is represented by the length of crank radius line intercepted by the valve circles. Referring to the diagram in Fig. 5, let J be the crank position and Z the eccentric position at any instant. The outer circle J A Z is the valve travel circle, the valve travel being represented by its diameter. The two smaller circles are termed valve circles and these are drawn with a diameter equal to half the valve travel or, in other words the eccentricity.

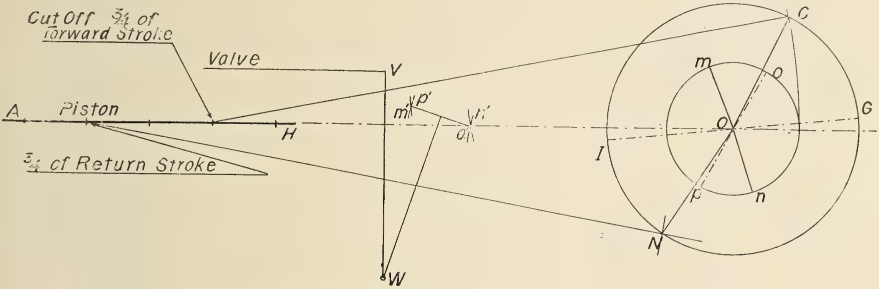


Fig. 4.—Equalizing Cut Off by means of Rocker Arm.

The part Ob of the eccentric radius which is intercepted by the valve circle ObF represents the valve displacement, that is, the amount the valve has moved from its central position. The reason for this is as follows:—We know that the valve displacement when the crank is at J and eccentric at Z is, Oa, aZ being a vertical line through Z on J F. It can be proved that, upon joining b F, the two triangles O b F and O a Z are equal in every respect, that is Ob = Oa or Ob, while the intercept of the eccentric radius by the valve circle represents the valve displacement for any position of the eccentric.

The diagram proper is shown in Fig. 6, and may be constructed in the following way: Describe a circle KXA with a diameter equal to the valve travel, and draw in the dead centre diameter KA. From O on the line KA measure off the lap OB and the lead BC. Through C draw a line at right angles to the dead centre line cutting the valve travel circle at the point F. Draw a diameter through the point F, namely F O J. Using the line O F as a diameter, describe the valve circle O F C and likewise on O J construct the valve circle W O J. With O as a centre, draw the steam lap circle W Q B and also the exhaust lap circle (w q c) with radii equal to the steam lap and exhaust lap respectively.

Where the valve circles intercept the steam lap circle, draw the crank diameters G P and R E. Also through the points where the exhaust lap circle cuts the valve circles, draw the diameters V L and H N. Through the centre O, midway between the two valve circles and at right angles to F J draw the crank diameter M T. For purposes of explanation draw any radius O Z of the valve travel circle.

Considering that the cylinder is to the right and the engine runs over, we will now locate the different points in the stroke at which the cylinder events occur. As before explained, the distance the valve has moved from its central position for any crank position is shown by the amount cut off the radius drawn through the point by the valve circle. At the point of admission, the displacement must equal the lap of the valve. The point of admission then, is at E because when the piston is at this point, the valve displacement or the part of the crank radius cut off by the valve circle is OD, which is equal to the radius of the steam lap circle and is, of course, the lap.

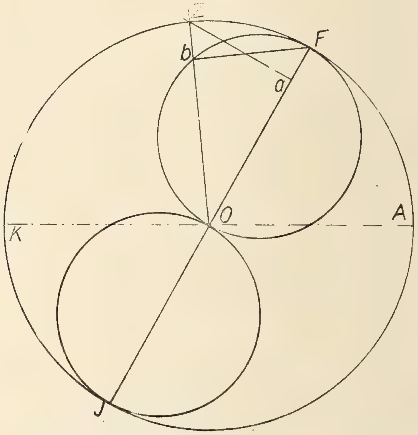


Fig. 5.—Diagram Showing Proof of Zeuner's Theory.

At the dead centre point A, the valve displacement is equal to O C or the lap O B plus the lead B C. When the crank reaches Z, the valve displacement is equal to Ob, therefore the port opening is (a b). At the point F the valve circle intercepts the whole radius O F which represents the eccentricity or the greatest valve displacement. The port opening is here equal to f F which is the greatest possible. The point F then, is the crank position for maximum port opening. As the crank pin moves around to G we find that the valve has moved back until the part intercepted by the valve circle is equal to O Q or the lap, and there is no port opening whatever. This point G is therefore the crank position for cut-off.

In the same way as with the steam lap circle, the part of the crank radius intercepted by the exhaust lap circle represents exhaust lap. At the point H, we find that the valve displacement is equal to Ow, which is the exhaust lap. That is, the port is about to open to exhaust, and H therefore is the crank position for release. This, it is seen, takes place slightly before the beginning of the return stroke just as admission takes place a little before the forward stroke. As the crank pin comes round on the return stroke, nothing particular happens until the point L is reached, when the valve displacement Os is again equal to the exhaust lap. The port is about to close to exhaust, and compression takes place.

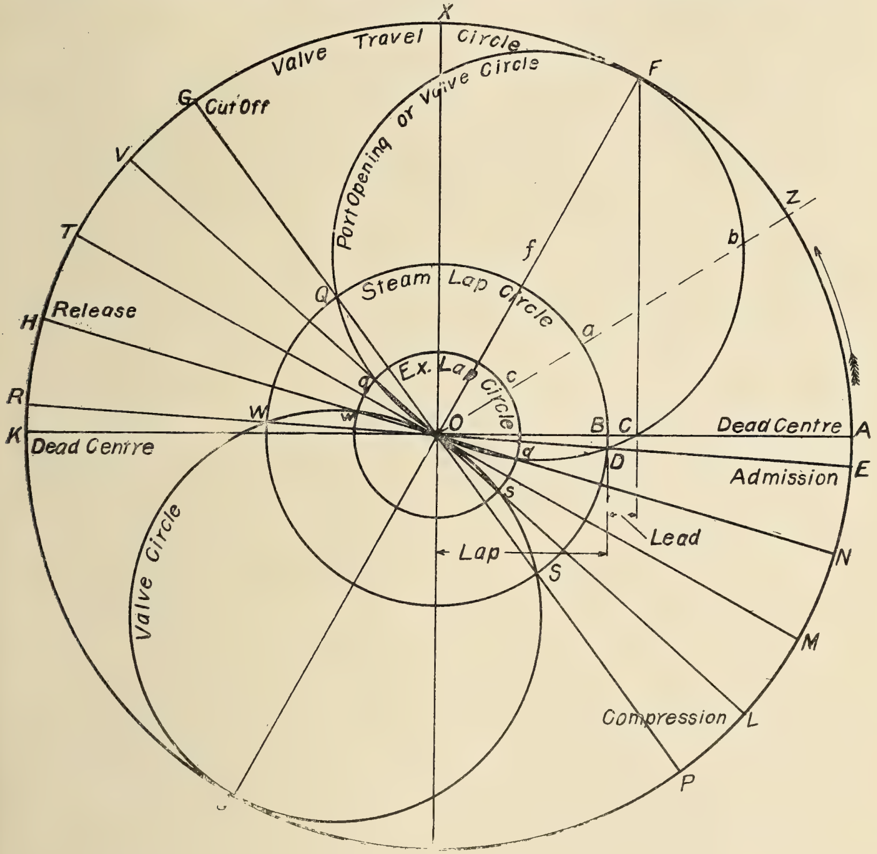


Fig. 6.—Complete Zeuner Diagram.

The cycle is completed as the crank returns to E the point of admission. At the points T and M, of course, the valve is in its central position and all ports are closed.

The time occupied in or the proportion of the stroke in which the crank pin is going from E to G is called the period of admission. That used in going from G to H is known as the period of expansion. From H to L is exhaust and from M to E is the period of compression. For certain purposes it is seen that this diagram is even more simple that that of Bilgram, and a little study will show that it can be used in the same way to obtain any desired information in connection with valves and gearing provided sufficient data are given.

To determine the correct piston position for any point in the stroke, Dr. Zeuner used a supplementary diagram such as that shown in Fig. 7. The large circle A B R is drawn with a radius AO, representing the length of the connecting rod plus the length of the crank arm to some convenient scale. With a centre P and a radius A P equal to the connecting rod, describe another circle A K touching the larger circle at A. With a centre O, the same as the large circle, describe the small circle P P which, of course, has a radius equal to the crank arm.

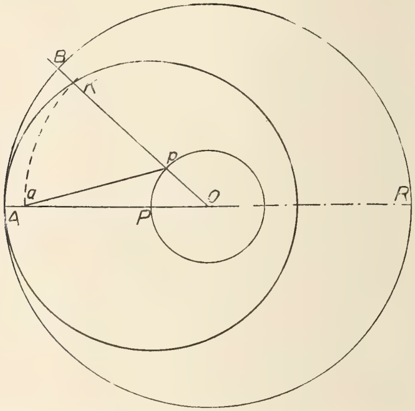


Fig. 7.—Auxiliary Diagram for Determining Piston Position.

The lines AP and PO represent the connecting rod and crank arm respectively when the engine is on dead centre. Let pO be any other position of the crank and produce pO to B. It is easily seen that BK is equal to Aa, and therefore, for any position of the crank the distance the piston has moved from its starting position is equal to the intercept between these two circles of the crank line produced. The value of these diagrams depends largely upon their accuracy and, for this reason it is usually best to draw them to an enlarged scale.

TWENTY-SIXTH ANNUAL DINNER.

The one function above all others which year after year emerges from the medley of University activities, enveloped in a distinctively encouraging and satiating atmosphere of pleasant recollection is the Annual Dinner of the Engineering Society. Each year the success which attends the "School" Banquet, voluntarily pronounces it as the best yet. The twenty-sixth annual dinner which was held at the Prince George Hotel on February 12th, can rightfully boast of an equal right to that of any of its predecessors to any distinction or precedence which fresh memories might give one over those which were no longer enhanced by still effervescent enthusiasm growing out of reunions and genial fellowship.

The Dinner this year was a remarkable success as a medium to afford a reunion of "School" men, and an opportunity to discuss matters relating to engineering and the "School" and cement even more firmly the bond which binds the graduates and undergraduates together as one harmonious unit. It was also unique in that unusual vent was given to patriotic expression, as about 70 of our members are either with the British Army or the First Canadian Contingent, and a large number have enlisted for active service with the Second and Third Overseas Contingents. The undergraduate members in Toronto who had enlisted for active service were guests of the Engineering Society. A pre-dominant trend of patriotic feeling pervaded the gathering, and the addresses of the evening and their reception voiced in no uncertain way the loyalty of those assembled, to the "School" and to our Country.

Over three hundred were present including Hon. W. H. Hearst, Premier of Ontario; T. R. Deacon, '91, ex-mayor of Winnipeg, and President and General Manager of the Manitoba Bridge and Iron Works; T. L. Church, mayor of Toronto; W. H. Taft, ex-president of United States; Dean Goodwin of Queen's University, President Falconer, Dean Ellis, D. Moliter, C. E., J. B. Challies, '04, Superintendent Water Power Branch, Department of Interior, Ottawa, and J. L. Morris, C.E., '81, the first graduate from the School of Practical Science, and W. J. Fitzgerald, President of the Ontario Surveyors Association.

In his opening remarks, Mr. Gray, the chairman, expressed the gratitude of the Society to those who had helped to make possible a Dinner of such promising success. When he proposed the toast to "The King" it is doubtful if ever 300 lusty voices ever sang with greater and truer meaning the National Anthem of the British Empire.

The toast to "Canada and the Empire" which was proposed by R. D. Galbraith, '15, was replied to by Premier Hearst, who was at his best. His excellent portrayal of the extent and richness of Canada's resources and the magnitude of the possibilities that lie before our Dominion evoked round after round of unrestrained applause. He appealed to Canadians to rise to their opportunities of the present time and share in the glory which will be ours when military autocracy shall have been crushed and peace again restored among the nations of the earth. We should now give all for the Empire in men and money and then devote our energies to the development of Canada until she makes her place among the confederations of the world.

Mr. Taft spoke in reply to the toast to the United States and briefly outlined the work which had been accomplished in the construction of the Panama Canal. Much of that was done by the war department while Mr. Taft was Secretary of War for United States and he consequently was well acquainted with much of the work and the difficulties which were encountered in completing so great a task. The difficulties were not all of an engineering nature, the chief problem being the necessity of making provision against fevers of the tropical country.

"Our Graduates" were toasted by E. H. Scott, '15, and T. R. Deacon, '91, replied. Mr. Deacon's address was forcibly delivered and contained very much of real interest to "School" men and to others as well, who are interested in the development of our country's resources. The wealth of our country depends not upon her tall buildings and her great areas, but upon the mettle of her manhood and the development of her natural resources. He appealed to the Dominion Parliament and to the Provincial Legislatures to give greater assistance toward technical education if they wish the wealth now dormant, to be placed at the disposal of our people.

Mr. H. O. Leach, '15, proposed the toast to "The University and the Faculty of Applied Science and Engineering." In replying, President Falconer demonstrated the deep interest which he feels toward the University and her students when he spoke as follows,—

"The Faculty of Applied Science has been remarkable for the spirit of unity with which it is pervaded. There is no other faculty in the university that exhibits such unanimity of feeling and that rallies more whole-heartedly to the interests of the faculty itself. It is a good example for the other faculties of the university in this respect. The dinners of this faculty therefore are pervaded by the best of feeling.

"A few days ago I visited some of the Eastern Universities of the United States. The impression that I received was that they are conducted on a much more elaborate scale than we have hitherto been able to approach in the University of Toronto. Their staffs are large; they have elaborate buildings and well equipped laboratories. It is our duty to follow on as closely as we can. Our people must be taught that education is the foundation of progress, and the educated man from the universities must carry this message to the people throughout the length and breadth of the land. Progress is to be measured by the way in which the people of a country prove to be masters of their environment. The educated man is one who has control of his faculties and who wherever he goes is able to turn to his use the material conditions by which he may be surrounded. The supremacy of mind over a nation's physical endowment will be the standard of their advance as compared with others. It will, therefore, become more necessary to educate our people who will occupy our own positions with satisfaction and honour.

"Turning now to the experience of the session through which we are going, it has been to me a year of deep tragedy. You have rallied in a wonderful way to the Officers' Training Corps, which has been fit and proper, and yet it is extremely sad. As I look forward to the next year I cannot say that the cloud seems to lift, for many of you will be away, and many may never return, and yet go you must if your duty calls you. This year will be a year to which our children and their children will look back as a year in which the mettle of their fathers was tested. One great satisfaction that is coming out of this sad year is the proof that our generation is as good as any generation of our fathers was. We do not need to look back to Waterloo for heroism. Nothing in British annals has surpassed the retreat from Mons. The action of our men is as heroic as it has ever been, and our Canadians are willing to do their best. There is no decline in the stamina of the race. You have come to the University at a great time, a great testing time, a sad, profoundly sad time, but when you have come through it you will realize that it has been a wonderful period. Some of you may not come through it, but I believe that there are larger issues of life than the present span of years, and in the truth of the Old Word that he who loseth his life shall find it."

Dr. Ellis also gave a very interesting address in which he congratulated the engineering students on the splendid response they were making to their country's call. The Kaiser of Germany had thrust his hand into the melting pot of international politics, and that hand being out of harmony with the contents and their purpose, had caused an explosion which had set the whole world ablaze. He regretted the necessity of the young men risking their lives for their country but was proud to know that they were so nobly answering the call of honour, freedom and liberty.

Mayor T. L. Church, K.C., President of the Union of Canadian Municipalities followed, responding to the toast to

"The City of Toronto," which was proposed by H. M. Black, '15, and said in part:—That he hoped some day in the near future a monument would be built to the memory of the late Dean Galbraith, who had done so much to build up the University of Toronto.

If they sought this monument they had just to look around them in Canada; to the various municipalities where, in many of them, the Head was a pupil of the late Dean. He was a man who had a manner which was characterized by great sociability, amiability, urbanity and great personal popularity. He was "to the faults of the students a little blind and to their virtues very kind, but always kept the padlock on the mind".

The Mayor said that there was sufficient brains in Canada without running to the United States or elsewhere for engineering ability; he advocated a policy of "Canada for the Canadians" in the engineering profession.

The Universities of Toronto, McGill and Queens had done a great deal through their Engineering Departments to build up Canada, and the time had now come for the Governments, Dominion and Provincial, to get together and capture the German trade. They should carry on in the universities, necessary investigations in every way, and secure the secrets of the industrial success of the Germans in a scientific way so that our industrial expansion may go ahead. Further, the Governments should utilize the students and the various technical departments of our universities to solve this great question. The German patents are cancelled in the British Empire, and now is the time to strike, and secure their trade. United effort and mutual benefit should be the watchword in solving it.

The Government should also restore single fare rates for the students of our universities in Canada, which the railways took away from them in 1912, and as President of the Union of Canadian Municipalities he had taken the matter up that week with the Government. A further question should also be taken up of providing work in the summer months, through the various Governments for the students of the Canadian Universities. There was plenty of work to do if the Governments would lend their active assistance in developing Canada.

"The Engineering Branch of our City is largely made up of graduates of the School of Science, as is the Engineering Department of the Harbour Board and the Hydro-Electric Commission. This School has furnished us with our best men. They are hard workers, and they are enthusiastic over their work, as well as able and capable. He wished the Engineering Society even greater success in future.

"There is no class of the community who have responded more nobly or heroically to the call of arms and to the call of

"Your country needs you" than had the students of Canada. They have enlisted in thousands and gone to the war, following the admirable example of University men of the British Isles."

"Sister Institutions" were proposed by E. M. Monteith, '15, which toast was replied to by G. J. Smith and Mr. F. C. Montgomery, representatvies from Queens and McGill respectively. Dean Goodwin of Queens also spoke for a short while and referred to the military work which was being done by the engineering students in Kingston.

Mr. R. B. Sinclair then proposed a toast to "Our Absent Members". He very appropriately made reference to those who had enlisted for active service and those who were already on the firing line. "These men," he said, "may not all come back but they are showing the mettle of which they are made and will bring honour to themselves and their Alma Mater. There is one," he said, "who has been taken from us and whom we cannot and would not forget on this occasion. For twenty-five years our late Dean had been the central figure at our annual banquets and we feel that we should pay tribute to the memory of the one who had fostered the Society for so long."

A vocal solo was rendered by W. K. Greatrex, '17, and the Science Quartette gave several selections. Music was provided by the Toike Oikestra under the leadership of G. W. F. Johnston, '15.

The following cablegram was later sent to Col. C. H. Mitchell and other members of the Engineering Society now at the front.

"Engineering Society entertained School men of the second contingent at annual banquet. Speakers were Taft, Hearst, Falconer, Ellis, Deacon and Church. All united enthusiastically in sending greetings and best wishes to all School men. Many declare they will drink health of School, Canada, and democracy with you in Berlin. Signed, President E. D. Gray."

LETTER TO THE EDITOR.

The Editor, Applied Science, Toronto University.

Sir:—

When in Montreal the other day, the Chief Engineer of one of the Departments at Ottawa, said to me—"There is one fault I have to find with your Engineering School in Toronto, you don't advertise. You are doing the best work in Canada and very few people know it."

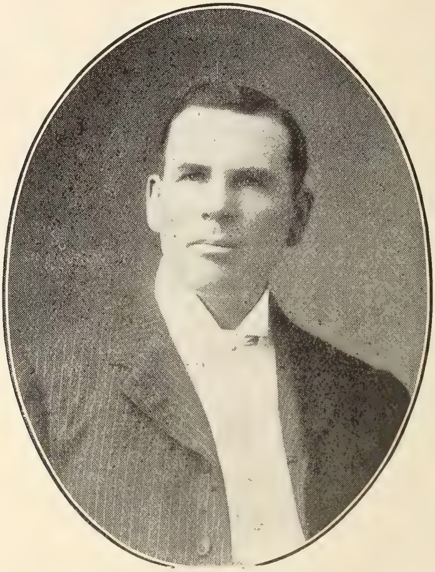
Yours faithfully,

H. E. T. HAULTAIN.

BIOGRAPHY.

Thomas Russ Deacon, '91.

This young but expansive country of ours owes much of her development to the students of Applied Science and Engineering in Canada, foremost among whom are the graduates of the School of Practical Science. It is doubtful if, among these men, there is another who has played a greater part in the upbuilding of the Dominion than has Thomas Russ Deacon, a graduate of 1891. The field of his work extends over all the provinces, while his greatest efforts were probably concentrated in the newer provinces of the West.



THOS. RUSS DEACON, '91.

Mr. Deacon was born on January 3rd, 1865, on a farm in the county of Lanark, Ont. He received his Public School education in Lanark County and attended High School in Pembroke, Ont.

After matriculating he was engaged in the Rocky Mountains, as assistant on the original survey of the Banff National Park Reserve in 1887. During the course of his work he discovered the way to ascend Cascade Peak and bears the distinction of being the first white man to reach its summit.

Upon graduating from the "School" he received employment during the summer of 1891 as instrument man on Township sub-division survey work in Algonquin National Park. He was engaged on survey work of various kinds in the Sudbury district during the following winter and during the following summer of 1892 he was engaged on the construction of the North Bay water works. In the Fall of 1892, Mr. Deacon went to Rat Portage (now Kenora), where he was engaged as town engineer and also carried on a private practice in survey work and mining engineering.

In 1897 he became manager of The Ontario Gold Concessions, Ltd., and did a large amount of prospecting on their behalf, sinking forty-seven different shafts and diamond drilling thousands of feet. In 1899 he was appointed Managing Director and Consulting Engineer of the Mikado Gold Mining Co., then operating the largest gold mine in Ontario.

He resigned this position as well as that of consulting engineer with various other companies and went to Winnipeg in 1902 to found and organize The Manitoba Bridge and Iron Works, Ltd., one of the leading manufacturing industries of Canada, west of the Great Lakes. This Company, of which Mr. Deacon is the largest shareholder, fabricated and erected the first railway bridge, the first highway bridge and the first steel building ever manufactured west of the Lakes in Canada.

He has served on the executives of all the large business organizations in Winnipeg, such as the Board of Trade, the Builders' Exchange and the Industrial Bureau and served as Provincial Vice-President of the Canadian Manufacturers' Association. He was also one of the three members of the Royal Commission on Workmen's Compensation, who drafted the present Manitoba Act "re compensation for injuries to workmen".

In 1906 he was appointed a member of a commission to inquire into the question of a permanent water supply for Winnipeg. Mr. Deacon was the first person to propose bringing water from Shoal Lake, adjoining the Lake of the Woods. He pointed out in a speech before the Board of Trade that his investigations and preliminary surveys had shown the proposition to be feasible. The Board of Consulting Engineers who had been appointed to assist in solving this serious problem were much impressed with Mr. Deacon's plan, but on account of insufficient data, they recommended getting water from the Winnipeg River. However, as the city was at that time busily occupied with its hydro-electric scheme, the water question was pushed aside until the growth of the city and the inadequacy of the artesian supply was brought sharply to attention by a severe shortage in 1912. The council submitted a by-law asking the people to spend about $2,000,000 more on the artesian supply. Mr. Deacon wrote letters to the papers advising the people to defeat the by-law and solve the problem in a proper way.

The by-law was defeated and Mr. Deacon was practically forced to be a candidate for mayor. He was elected and organized the Greater Winnipeg Water District, and after complete surveys were made he showed that the Shoal Lake scheme to bring in 100,000,000 gals. per day by gravity was quite feasible. A by-law was carried by a very large majority whereby the citizens of Winnipeg voted $13,500,000 toward the carrying out of this scheme to bring a supply of water a distance of 95 miles. The work is now under way, a standard railway having been built over the whole length this last year and the contracts for the work let at $1,600,000 below the estimate.

He held the office of mayor of Winnipeg for two years and retired voluntarily at the end of 1914, although urged by the largest petition ever presented to a mayor in Winnipeg, to accept the office for another year.

The following motion taken from the minutes of the Winnipeg Council, December 28th, 1914, portrays in some degree the appreciation with which Mayor Deacon's services were regarded by the citizens and his colleagues.

"Moved by Ald. Milton,

"Seconded by Ald. Wallace,

"The Council of the City of Winnipeg desires to place on "record its hearty acknowledgment and appreciation of the "value and efficient services rendered to the City by His Wor-"ship Mayor Deacon during his term of office as Mayor for the "years 1913 and 1914.

"The City of Winnipeg is deeply indebted to His Worship "for initiating and carrying out to a successful conclusion many "improvements and reforms adding to its prosperity and em-"bellishment, and the Council believes it is but voicing the "sentiments of all citizens in testifying to his untiring energy "and devotion to the duties of his office.

"Upon retiring from office, His Worship carries with him "the good wishes of each and every one of his associates on "the Council, and they trust that the success which he has had "in civic administration may continue in his private life.

"Be it further resolved that His Worship be presented "with the chair which he has occupied as Chief Magistrate of "the City adorned with a plate suitably inscribed, and the "Council express the sincere wish that he may long be spared "to use the same.

Carried unanimously."

Dushman-Leff.

In New York, on June 28th, 1914, Mr. Saul Dushman, B. A., Ph. D., of the General Electric Co. and formerly Lecturer in Electro-Chemistry at the University of Toronto, was united in marriage to Miss Anna Leff of New York City.

A SOUTHERN BRITISH COLUMBIA POWER SYSTEM

By VINCENT S. GOODEVE, '10.

Many people in the Eastern provinces of our Dominion are inclined to regard British Columbia as a comparatively new and undeveloped province. Yet, as far back as 1897 gold and copper mining and smelting had reached such a stage as to cause far-seeing men to begin the construction of a hydraulic power plant to supply the promised market. I refer to the West Kootenay Power & Light Co., from whose system nearly all the mining and smelting industries of what is known as the Kootenay and Boundary countries, are supplied with power. Much of the ore in these districts is of such low grade as to require a good supply of cheap power in order that the ore may be handled in sufficient quantities to render its mining and smelting profitable.

In 1908 the company were supplying power from their first plant situated at Lower Bonnington Falls on the Kootenay River about ten miles from Nelson. The available load at that time was 1,000 h.p. at the end of a 32 mile transmission line. That the venture of the company was justified is evidenced by the fact that this original plant of 4,000 h.p. capacity, is now used as a stand-by while their second plant at Upper Bonnington Falls, about one mile from the first and of 16,000 h.p. capacity, together with No. 3 plant at Cascade City on the Kettle River and of 3,900 h.p. capacity, are required to supply the present load. No. 2 plant was completed in 1907, and in the same year the company took over the system of the Cascade Water, Power and Light Co., including what is now the No. 3 plant, which was supplying power in the Boundary country but which had not the capacity to supply the increasing demand. Forthwith, the Bonnington power was extended into this country and arrangements made whereby either source may be utilised to supply a limited supply of power to the other system in the event of a breakdown or shutdown for any cause.

The transmission voltages and places supplied from the various plants are as follows:—

No. 1 plant—Dead, and its customers supplied by special transformer in No. 2 plant, transmitted at 22,000 volts to Rossland, Trail and Silver King Mine.

No. 2 plant—60,000 volts supplied to Rossland, Grand Forks, Phoenix, and Greenwood.

No. 3 plant—22,000 volts, supplied to Grand Forks, Phoenix, Greenwood and Boundary Falls.

All current is transmitted at 60 cycles and stepped down to the prevailing distribution voltage, usually 2,200 volts, at the various sub-stations.

Someone has rightly said that if the province of British

Columbia were flattened out it would have twice its present area. The building of a transmission line in such a country is not an easy task. The power must go wherever the mines and smelters are located. The smelters must be built wherever the character of the land and the railroad facilities will permit. These conditions lead the power lines over rough land to altitudes of six thousand feet and down again to two thousand feet. The patroling and repairing of such a line is an expensive matter, and the company found it better to build a line requiring very little attention but costing more than the flimsier line. The 60,000 volt line is a model in this respect and its 84 miles of duplex three phase line give remarkably little trouble. It is also remarkably straight considering the character of the country through which it passes. The heavy cedar poles are spaced only from 100 to 150 feet apart. The cross arms are heavy and the butts are often placed in blasted holes in solid rock. Only a few freak poles have shown signs of decay as yet, and only once or twice has the lightning been known to set fire to the pole or cross-arm. The line is not sectionalised. One line can carry all the load, so that as soon as trouble is found to be on either line, the entire load is thrown on the good line. Being on separate poles, trouble on one line does not cripple the other. So amply has the system been designed that it has not been found necessary to transmit at the rated voltage as yet, but current is transmitted at 40,000 volts by using taps in the windings of the transformers at the generating and receiving stations. This causes a saving in the expenses of locating and replacing broken down insulators for even the most up-to-date systems have breakdowns now and then from flaws in apparently good porcelain and stresses due to internal surges. The cables are arranged in an equilateral triangle by placing one cable at the top of the pole. The other two are on the crossarm. This formation is desirable to equalize the mutual induction of each wire on its mates and to facilitate transposition.

All the buildings and equipment of the system were designed to last and to accomodate large additional capacity. The available power at Upper Bonnington Falls is only partly developed even with the addition of another 8,000 h.p. unit, which is being installed at present. This last addition will be required to supply power for the electrification of the C. P.R. from Castlegar to Rossland. The sub-stations are all built along the same plans. Separate rooms are provided for each bank of transformers, the high tension switching equipment, and the switchboard and operating room. No provision is made for elaborate systems of relays to disconnect lines when the voltage drops or the current is interrupted. The simple inverse-time-limit overload relays afford sufficient protection on both the high tension and feeder switches.

Much difficulty was experienced in erecting Power House No. 2. Over 70,000 cubic yards of solid granite had to be excavated for the forebay, powerhouse site and tail race. The building is reinforced concrete and is not at all ugly or out of keeping with the natural beauty of its surroundings. The interior is roomy and provision is made in the present building for four units of 8,000 h.p. capacity each. Two of these are installed and in operation and a third is now being installed as mentioned before.

In this article I have endeavored to omit the quoting of capacity data and similar information as I have always found that it makes wearisome reading. Instead of detailing the equipment of the powerhouses and substations, which is pretty much standard and is familiar to most students interested in power plant construction, I have outlined some of the conditions under which this system was constructed and is now operated. Every little system has troubles all its own and it is these peculiarities which make the descriptions of plants and systems interesting.

WHAT OUR GRADUATES ARE DOING.

M. B. Watson, B.A. Sc., '10, who accompanied the First Canadian Overseas Contingent has recently been appointed Lieutenant with the Royal Canadian Engineers.

J. F. Henderson, '10, is resident engineer for Chipman and Power at Thorold, Ont.

J. H. Carter, '07, is with the Hydro-Electric Power Commission of Ontario, Continental Life Building, Toronto.

F. W. McNeill, B.A. Sc., '07, is with the Canadian General Electric Co., Ltd., at Calgary, Alta.

C. Noecker, B.A. Sc., '14, is at St. Thomas, Ont., with James A. Bell & Son, Surveyors and Engineers.

Rex P. Johnson, B.A. Sc., '14, is on the designing staff in the Welland Ship Canal office, St. Catharines, Ont.

J. H. Dawson, '09, is assistant resident engineer, section 5, Welland Ship Canal, Allanburg, Ont.

H. M. Campbell, B.A. Sc., '14, has received a commission as lieutenant with the Second Contingent and is now with the Seventh Canadian Mounted Rifles in the concentration camp at London, Ont.

C. C. Forward, '06, is analyst in charge of the laboratory of the Inland Revenue Dept., at 48-50 Bedford Row, Halifax, N. S.

Norman M. Lash, '94, formerly Assistant Chief Engineer for the Bell Telephone Company of Canada, has recently been appointed Chief Engineer of that Company, with offices in Montreal, Que.

L. W. Morden, '05, is with the Packard Electric Co., St. Catharines, Ont.

L. H. Robinson, '04, is Assistant to the Engineer of Construction, Intercolonial Railway Company, Moncton, N.B.

W. deC. O'Grady, '08, is Assistant Branch Manager, Ford Motor Car Company of Canada, Ltd., at Calgary, Alta.

T. L. F. Rowe, '11, is Superintendent of Construction on the Hospital for Insane, Whitby, Ont.

F. H. Chestnut, B.A. Sc., '08, is located in Marshfield, Oregon, U.S.A., where he is in business under the name of the "Coast Equipment Co." handling engineers' supplies and equipments.

A. W. Chestnut, B.A. Sc., '10, who was Assistant Engineer for the Foundation Company of New York, in the work of straightening up the C.P.R. elevator at North Transcona, is now at Le Pas, Man., engaged in gold mining.

J. C. Martin, B.A. Sc.,'11, is with the Northern Electric Co., Montreal, Que.

A. P. Augustine, '07, has a land surveying practice at Prince Rupert, B.C.

J. D. Shepley, B.A. Sc., '04, has a private practice in surveying and engineering at North Battleford, Sask.

H. R. Banks, B.A., Sc., '14, has accepted a position with the Consolidated Arizona Smelting Co., Humboldt, Arizona, U.S.A.

Marani and Moore

V. G. Marani, C. E., '93, and J. E. A. Moore, C. E., '91, have a practice at the Euclid Building, Cleveland, Ohio, as Consulting Civil and Mechanical Engineers under the firm name of Marani & Moore. They make a specialty of conditions and engineering features relating to the matter of reducing fire hazard, while they are engaged in a consulting capacity on almost every kind of engineering work.

Mr. Marani was Constructing Engineer for the Cleveland Gas, Light and Coke Co. from 1895 to 1906. He was Engineering Superintendent of Cuyahoga County Court House from 1906 to 1909, and during 1910-11 he was Building Commissioner of Cleveland.

Mr. Moore was Resident Engineer, Ore Dock and R. R. Terminal Construction, Duluth, Minn., 1891-94. During the following three years he was Structural Engineer, Riter Conley M'f'g. Co., Pittsburgh and afterwards was Chief Structural Engineer, Wellman, Seaver, Morgan Co., Cleveland, Ohio., until 1900 when he was appointed Chief Estimating Engineer for the same company. In 1907 he became partner with the late J. W. Seaver, Consulting Engineers. From 1911 to the date of the recent establishment of the new firm, he was Chief Engineer, C. O. Bartlett Snow Co., Cleveland, Ohio.

APPLIED SCIENCE

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Engineering Bldg., University of Toronto,
Toronto, Ont.

EDITORIAL.

The following "School" men, in addition to those published before, have joined the Second Overseas Contingent:—R. E. Taylor, '17; C. M. G. Purchas, '17; F. C. Mayberry, '17; J. A. Macdonald, '17; C. K. Hoag, '17 (G.G.B.G.); D. German, '17; W. D. Armstrong, '17; R. E. Williams, '16 (Intelligence Corps, Field Artillery); J. S. Panter, '16 (Field Telephone Corps); H. B. Little, '16; J. A. N. Ormsby, '16; J. P. Cavers, '16 (Machine Gun Section); L. Husband, '16; L. B. Tillson, '15 (Machine Gun Section); N. H. Daniel, '15; Lieut. H. S. Kerby, '14 (Can. Aviation Corps); Sergt. J. M. Robertson, '14 (14th Battery C.F.A.); Lieut. H. M. Campbell, '14; A. A. Swinnerton, '16; A. A. H. Vernon, '18; E. F. Norris, '17 (Machine Gun Section).

Lieut. H. H. Betts, '06, who after graduation was with the Rio de Janiero, Light and Power Company, Rio de Janiero, Brazil, S.A., and who spent the last two years on work in Spain, is now with the British Railroad Troops, Boulogne, France.

LETTER FROM A "SCHOOL" MAN AT THE FRONT.

The following letter was received by Professor Haultain from F. C. Andrews, B.A. Sc., '14, who sailed from New York after war was declared and joined the British Army.

Northern France, Jan. 13, 1915.
(I am not allowed to give any address.)

Dear Professor Haultain,—

You will perhaps be surprised to hear that I am out here in the middle of the row. I left England about Dec. 17th and my first day in the trenches was Xmas day.

This place isn't too bad only it is so confoundedly wet and muddy. The part I am in is very low lying and owing to the enormous amount of rain we are nearly drowned out. The trenches themselves are awfully wet and muddy and it is quite impossible to get a dry place to stand or sleep in, one is always wet and cold and simply covered with mud, the very wettest mud I have ever seen. The only consolation we have is that the Germans are in the same fix, and we try to imagine, worse than ourselves.

The last trenches we were in were the worst probably in our division; the mud and water was bad, but really the worst part of it was the dead Germans and our own men we uncovered when we were digging. Most of these men were killed in an advance and were buried in a most haphazard manner, especially the Germans; they simply chuck them in a shell hole, leaving a foot or an arm sticking up. Our men are awfully decent to the dead, take a lot of pains burying them and putting up crosses over them, but the Germans are most haphazard in their methods. I watched them one day.

On Xmas day we had a truce with the Saxons in front of us, purely unofficial, and talked to them between the trenches, in fact I think a photograph was taken of a mixed crowd of Germans and English. The Saxons are a very decent crowd and appear from their actions to be heartily sick of the war.

We were relieved out of the trenches a couple of days ago and went into billets; we are very comfortable, indeed, but unfortunately to-morrow at 4.30 a.m. we go into them again. The chief danger in the trenches is the sniping which goes on constantly and gets rather annoying, but one grows used to it in time. A few days ago our artillery shelled the German ternches on our left front, most wonderful signt, seeing the shells bursting several at a time, great clouds of smoke and earth and Germans running around. They shelled back but didn't do much damage.

The Canadians are, I understand, still in England, but ought to be out soon. I suppose I am about the only "School" man out here at present, there can't be many more Canadians here yet.

Yours very sincerely,

(Signed) Fred Andrews.

UNIVERSITY OF TORONTO CLUB OF NEW YORK.

The University of Toronto Club of New York held its thirteenth annual banquet on Wednesday, February 3rd, at the Hotel Astor.

President Louis L. Brown, S.P.S. '95, presided and the guests of the evening were President Falconer, the Rev. Dr. Wm. Carter of New York, Prof. McPhedron and Prof. C. H. C. Wright.

The banquet was very successful in every way, there being a large attendance of members, who were most enthusiastic in their applause of the speakers as they referred to the notable part that Canada and particularly the University of Toronto was taking in the Great War.

President Falconer stated "Canada is not in this war by force. It is not with a spirit of bravado we have sent one hundred thousand men to the front. We are proud to be able to do what we are doing". It was very evident from the applause that greeted his remarks that the graduates down in New York are very proud too of the stand Canada has taken, and also particularly proud of the showing made by their Alma Mater.

Professor Wright spoke impressively in a very touching manner to the loss of our late Dean Galbraith, who so often had attended these banquets, and the feeling of sympathy was sincere from the graduates of Arts and Medicine, as well as Science.

Among the "School" men who were present were, H. F. Ballantyne, '93, Secy. and Treas. of the Club; E. W. Stern, '84; Dr. T. K. Thomson, '86; T. H. Alison, '92, and F. W. Harrison.

The Herbert Morris Crane and Hoist Company, Limited, Peter Street, Toronto, have just issued a new bulletin on the Morris Belt-Driven Friction-Hoist, giving the prices and general particulars of the hoists for various purposes and under various conditions, in tabulated form. The hoists and the principles governing their operation are well set forth by illustrations and diagrams.

BOOK REVIEW.

American Handbook for Electrical Engineers—By Harold Pender. Leather, 4¼ inches x 7 inches, 1969 pages. Publishers—John Wiley and Sons, New York. $5.00 net.

Reviewed by Professor H. W. Price, B.A. Sc.

Every student of electrical engineering is interested in a hand book which will serve as a convenient and reliable source of information on a multitude of topics in his line of interest. This new book is the most complete electrical handbook we have yet consulted.

Dr. Pender, the editor-in-chief, is Professor of Electrical Engineering at the University of Pennsylvania, which explains the fact that so much of the material is presented in form quite as useful to students as to engineers in practice.

The American Handbook contains 2,000 pages of carefully boiled-down information and data on a very wide range of subjects. It is well bound in leather. Instead of dividing all material under fifteen to twenty general headings, such as measurements, materials, transformers, central stations, electric traction, etc., this book is arranged alphabetically somewhat like an encyclopedia. Further assistance in locating information is offered in a topical index of articles, and a large detailed index containing about 6,000 items. Both in the index and at the head of each article are given references to other articles in the book where similar information is to be found under discussion from different points of view. Subjects requiring from ten pages upwards are also briefly indexed at the beginning of the article.

In so far as possible, all subjects such as apparatus or machinery are treated in routine manner: General description and definitions; applications; principle of operation; design; testing; performance; specifications; installations; operation; dimensions, weights, and costs; bibliography. A systematic plan of this sort applied to matter assembled by twenty-five engineers and scholars of recognized ability has resulted in a remarkable collection of information and data. Nearly every subject, electrical or mechanical, of interest, directly or indirectly, to an electrical man is given attention. Many subjects are well reviewed which most other handbooks hardly mention; for example, construction data on water rheostats for test loading of high and low voltage generators covers five pages, and all this information is to the point. One inconvenience in arrangement is noted. Mathematical tables of logarithms, trigonometric functions, hyperbolic functions, differential equations, etc., are scattered alphabetically. If collected under one general head such as mathematics, they would be vastly more convenient.

The American Handbook for Electrical Engineers will make a valuable addition to any engineer's collection of data.

THE VALUE OF EXECUTIVE TRAINING ON THE ENGINEERING SOCIETY EXECUTIVE.

There are no greater oportunities than those open to the Engineer. This is true whether he desires to remain in professional work or associate himself with any of the industrial pursuits closely allied with Engineering. In either case, it is essential that the Engineer of to-day be a man of business. He must at least have an intimate knowledge of business methods and principles. While the Engineer deals with the forces of nature he has no less to do with men and organizations. There are men who shut themselves up from the world and by close study evolve some great scheme or make an important discovery, but chances of success along this line are rare. The real business is done by teamwork and not by individual play. Tasks of importance are accomplished by large organizations where many men play important parts, and in which all combine in unison to secure strength. There are students in the School to-day of the hermit type who follow some one line such as, studies, athletics or social affairs. While it is essential that the undergraduate appreciate the value of academic work, is it not of equal importance that he study men? He should endeavor to acquire that quality of mixing with his fellows which develops tact, resourcefulness and judgment and makes life more pleasant. The Engineering Society of the "School" offers greater opportunity for this development than any other academic activity. In holding office on the executive committee a man is doing valuable work for the institution and although the duties of office at times are most exacting and the work heavy, the benefit to the "School" cannot be compared to the personal benefit he receives. A well contested election is a true sign of "School" spirit, and in running for office a man gains the acquaintance of many who later become true and intimate friends. It is no disgrace to be defeated by a good man. We have only to look for examples of success among the older graduates and find that they have invariably taken a keen interest in the welfare of their alma mater and most of them have been active on various executive committees of student organizations. These men did not seek mere personal advancement; the same traits of character that made them loyal to the "School" have given them that broad vision and appreciation of men and affairs in general which distinguish them as leaders. It has been truly said "Men have developed the capacity t odirect affairs only as they have learned to understand their fellowmen".

H. F. White, '03, is Assistant Superintendent, White Manufacturing Co., London, Ont.

G. Helliwell, '10, is Lieut. with the 1st Battalion, First Canadian Overseas Contingent.

C. E. Bush, B.A. Sc., '07, is Lieut. with the cyclist corps, First Canadian Overseas Contingent.

R. D. S. Beckstedt, B.A. Sc., '09, formerly Sales Agent for the Tagona Light & Power Company, Sault Ste. Marie, Ont., has been appointed superintendent for the same company.

Geo. G. McLennan, B.A. Sc., '10, is with the Hyland Construction Co., in charge of the power house construction at Eugenia Falls, for the Hydro-Electric Power Commission.

C. H. R. Fuller, B.A. Sc., '14, has been elected Secretary of the Toronto Branch, Canadian Society of Civil Engineers, for the ensuing year.

J. A. D. McCurdy, '07, is in Toronto endeavoring to make arrangements to establish a base here for the equipping and training of an aviation corps for military purposes.

W. J. White, B.A. Sc., '08, was, until about a year ago at the Boston office of the General Electric Co. He went from there to Perth, Australia, to the office of the British Thomson-Houston Co.

Wills Maclachlan, B.A. Sc., '06, has resigned his position with the Electric Power Co., and is now inspector for the Electrical Employers' Association of Ontario, with headquarters at 10 Adelaide St. E., Toronto.

At the annual meeting of the Ontario Land Surveyors' Association, held in Toronto, on Feb. 16th, 17th and 18th, F. N. Rutherford, B.A. Sc., '04, delivered a paper on "Possessory Titles". J. S. Dobie, B.A. Sc., '95, delivered a paper on "Stone Crushing" and another on "Roads and Pavements".

C. J. Townsend, B.A. Sc., '04, will in future carry on the business of the engineering and contracting firm of Wilson, Townsend and Saunders, with headquarters at 79 Spadina Ave., Toronto, Mr. Townsend having taken over the interests of the retiring partners.

R. A. Sara, B.A. Sc., '09, Sales Manager of the Winnipeg Light and Power Department, has returned to the West after a combined holiday and business trip of two weeks in the East, on which he visited Toronto, Montreal, Detroit, Chicago and Minneapolis to investigate the accounting systems in use by the various power companies with a view to improving, if possible, the system now used by the City of Winnipeg.

W. G. McIntosh, B.A. Sc., '09, has recently been appointed Sales-engineer for Toronto by the Herbert Morris Crane and Hoist Co., Ltd., manufacturers of lifting and shifting machinery, with works on Peter Street. Mr. McIntosh has had a very varied experience in shop work, draughting office work, and field erection, having previously been with the Otis-Fensom Elevator Company, the Toronto Power Company, the Canada Foundry Company and the Dominion Power Company.

DIRECTORY OF THE ALUMNI.

Bitzer, A. M., '09, is with the Second Canadian Contingent in camp at Ottawa.

Black, B. S., 513. His address is 197 Madison Ave., Toronto.

Black, G. E., '08, is with the Ontario Government at the Ontario Prison Farm, Guelph, Ont.

Black, R. G., '95, is a member of the Toronto Hydro-Electric Commission.

Black, W. D., '09, is superintendent of the eastern branch of the Otis-Fensom Elevator Co., with headquarters in Montreal.

Blackwell, R. H. H., '10, formerly resident engineer for the Canadian Northern Ry. at Biscotasing, Ont., is taking a post-graduate coure in engineering at the University of Toronto.

Blackwood, A. E., '95, is manager of the New York office of the Sullivan Machinery Co.

Blackwood, W. C., '06, is instructor in physics, Technical High School, Toronto.

Blain, D., '13, is draftsman for the Canada Foundry Co., Toronto.

Blair, W. J., '02, was located at Provost, Alta., when last heard from.

Bleakley, J. F., '85, is engaged in a general engineering practice at Bowmanville, Ont.

Blizard, D. C., '09, is with the Canadian Inspection Company on the inspection of shrapnel shells.

Blyth, J. M., '14. His home address is R. R. No. 3, Durham, Ont.

Boeckh, J. C., '06, is in Toronto, and is with the Boeckh Brush Co. as a member of the firm.

Bonnell, M. B., '04, is in the Patents Office, Department of Agriculture, Ottawa, Ont.

Bonter, E. R., '13. His home is at Trenton, Ont. He is at present with the Canadian Crocker-Wheeler Co. at Montreal.

Boswell, E. J., '95, is on the engineering staff of the Canadian Pacific Railway Co.

Boswell, M. C., '00, is lecturer in organic chemistry, University of Toronto.

Boswell, W. O., '11, is in electrochemical work. His home address is 25 Roxborough St. W., Toronto.

Boulton, W. J., '09, is Surveyor, Dept. of Interior, Ottawa, Ont.

Bourne, O. B., '07, is Resident Engineer, Greater Winnipeg Water District, Winnipeg, Man.

Bow, J. A., '97, is in Great Falls, Mont., with the Boston and Montana Mining and Smelting Co.

Bowen, G. H., '09, is Assistant Engineer, Distribution Dept., Toronto Hydro-Electric System, Toronto, Ont.

Bower, J. W. H., '14, has 15 Pleasant Blvd., Toronto as his address.

Bowes, H. F., '08, is superintendent of the Warren Bituminous Paving Co., Toronto.

Bowman, A. M., '86, was a member of the Pennsylvania Contracting Co., Pittsburgh, when last heard from.

Bowman, E. P., '10. His home is in West Montrose, Ont. We do not know his professional activities.

Bowman, F., '11, is draughtsman with the Dominion Bridge Company in the office at Lachine, Que.

Bowman, F. M., '90, is vice-president and director of the Blau Steel Construction Company, Pittsburgh, Pa.

Bowman, H. D., '07, his present address is E. D., Y.M.C.A., 179 Marcy Ave., Brooklyn, N.Y.

Bowman, H. J., '85, is a member of the firm of Bowman and Connor, consulting municipal and structural engineers, Toronto and Berlin, Ont. Mr. Bowman is engineer for the county of Waterloo.

Boyd, D. G., '94, is in Toronto, in the Department of Lands and Mines, Parliament Buildings.

Boyd, W. H., '98, is in the Topographical Branch, Geological Survey, Department of the Interior, Ottawa.

Brace, J. H., '08. His address is 23 Lorne Ave., St. Lambert, Que. He is with the Bell Telephone Co.

Brackenreid, T. W., '11, was in the employ of the Canadian General Electric Co., in Peterborough, Ont. when last heard from.

Brady, W. S., '07, is manager of the Madison Theatre on Bloor St. W., Toronto.

Brandon, E. T. J., '01, is assistant engineer for the Hydro-Electric Power Commission, Toronto.

Brandon, H. E., '06, is chief engineer of the Vulcan Iron Works, Winnipeg, Man.

Bray, L. T., '00, who has Amherstburg, Ont. as his permanent address is District Engineer and Surveyor for the Province of Alberta.

Brecken, P. R., '08, is secretary of the Broadview Branch of Toronto Y.M.C.A.

Brereton, W. P., '01, is City Engineer, Winnipeg, Man.

Breslove, J., '03. We do not know his present address. He was in the Westinghouse Machine Co., Pittsburg, when last heard from.

Brian, M. E., '06, is city engineer of Windsor, Ont., and also engineer for several adjacent townships.

Bristol, W. M., '05, is in the Halifax, N.S., office of the Canadian Westinghouse Co.

Broadfoot, F. C., '06. His address is 142 Hastings St., Vancouver, B.C. He is a member of the firm of Broadfoot, Johnston and Hamilton, Vancouver.

Brock, A. F., '10, is with the Canadian Copper Co., at Copper Cliff, Ont.

Brock, W. M., '11, is draftsman with [illegible]nadian Bridge Co., Wa[illegible] Ont.

Broughton, J. T., '01, is chief engineer of the Scotdale Foundry and Machine Co., Scotdale, Pa.

Brodie, W. M., '95, is travelling salesman for the Sterling Coal Co., Ltd., 95 Bay St., Toronto. We do not know his present address.

Brouse, W. H. D., '11, is in this city, with Kerry and Chace, Limited.

Brown, J .M., '02, was in the steam turbine department of the Westinghouse Machine Co., Pittsburgh, when we last heard from him. We do not know his present address.

Brown, T. W., '06, is a member of the firm Brown and Loucks, engineers and surveyors, Saskatoon, Sask.

Brown, D. B., '88, who was, when last heard from, locating engineer, Grand Trunk Pacific, is on our list of unknown addresses.

Brown, G. L., '93, resides in Morrisburg, Ont., and is engaged in civil engineering and surveying.

Brown, L. L., '95, is vice-president of the Foundation Company, Woolworth Building, New York.

Brown, T. D., '04, has a private engineering practice at Lethbridge, Alta.

Brown, J. A., '70, is engineer in charge for the Trussed Concrete Steel Co., Vancouver, B.C.

Brown, E. I., '08, is in the sales dept. of the Northern Electric and Manufacturing Co., Toronto.

Brown, C. E., '09, is in Hamilton, Ont., with the Canadian Westinghouse Company.

Brown, H., '11. His address is not on our files.

Browne, E. W., '09. His present address is unknown to us.

Browne, M. O., '10. His address is 313 McClellan Ave., Detroit.

Bryce, W. F. M., '08, is in the office of the city engineer, Ottawa, Ont.

Buchan, P. H., '08, is assistant engineer, construction department, British Columbia Electric Railway, Vancouver.

Buchanan, J. A., '09, is on survey work at Edmonton, Alta. His address is 140 Jasper St. W., Edmonton.

Buchanan, T. R., '13, is demonstrator in the department of electrical engineering at University of Toronto.

Bucke, W. A., '94, is manager of the Toronto district office of the Canadian General Electric Co.

Bunnell, A. E. K., '06, is assistant engineer, Federal Plan Commission of Ottawa and Hull, Booth Bulding, Ottawa, Ont.

Burd, J. H., '03, is engaged in survey work in Saskatoon, Sask. His address is P.O. Box 690.

Burgess, E. L., '03 is with the Topographical Surveys Branch, Department of the Interior. We understand that he is now located at Kamloops, B. C.

Burgess, J. R., '10, is inspector at the plant of the Algoma Steel Co., Sault Ste. Marie, for the Robert W. Hunt Co.

Burley, R. J., '04, is Division Engineer, Irrigation Office, Department of Interior, Calgary.

Burns, J. E., '09, is a member of the firm "Langrill and Burns, Advertisers' Agents," Dineen Building, Toronto.

Burnham, F. W., '04, is in the engineering department of the Canadian Westinghouse Company, Hamilton.

Burnside, J. T. M., '96. Deceased Dec. 3rd, 1914.

Burwash, L. T., '96. is manager, Western Supply Company, Winnipeg, Man.

Burrows, B. H. A., '13, is in charge of the Coleman Fare Box Co., at Tottenham, Ont.

Burwash, N. A., '03, is engaged in land surveying, Toronto.

Bush, C. E., '07, is lieutenant with the Cycle corps, First Canadian Contingent.

Byam, F. M., '06, is in the employ of McGregor and McIntyre, Toronto, as chief engineer.

C.

Cain, E. T., '11, is inspector in the Bridge Dept., I. C. Ry., Moncton, N.B.

Calder, J. W., '04, is in the city engineer's office, Port Arthur, Ont.

Cale, W. C., '10, formerly with the Stone and Webster Engineering Corporation, as engineer on transmission line construction at Keokuk, Iowa, is now with the Mississipi River Power Co. of that place.

Caldwell, W. B., '13, is with the Department of Roadways, Toronto.

Cameron, N. C., '04, is associated with the Dominion Engineering and Construction Company, of Montreal.

Cameron, A., '06, is in Winnipeg, Man., in the employ of the Vulcan Iron Works, Limited.

Cameron, M. G. '09, has no address with us at present.

Cameron, C. S., '11, has Beaverton, Ont., for his home address.

Cameron, D., '08, is with the Lake Erie and Northern Railway, Brantford, Ont.

Cameron, O. L., '13, is engaged on pitometer survey work for the city of Toronto.

Campbell, A. D., '10, is in Cobalt, Ont., as mining engineer for the O'Brien Mines.

Campbell, A. J., '04. We do not know his address.

Campbell, A. M., '04. We have not his present address.

Campbell, L. L., '13, is engaged in survey work at Berkeley, Cal. His address is 2408 Fulton Street.

Campbell, W. G., is a member of the firm "Campbell and Lattimore, Railway Contractors," 2 King St. E., Toronto.

Campbell, A. R., '02. Deceased.

Campbell, D. H., '14, is with the Topographical Surveys Branch, Department of Interior, Ottawa.

Campbell, R. J., '95. We do not know his address.

Campbell, G. M., '96. was superintendent of the power apparatus shops of the Western Electric Co., at Riverside, Ill., when last heard from.

Campbell, J. J., '14, is resident engineer with Chipman and Power, Toronto.

Campbell, N. A., '08, is with the General Supplies Limited, 122-11th Ave. W., Calgary, Alta.

Campbell, R. A., '09 is engineer in charge of the Municipal Lighting Plant, Sault Ste. Marie, Ont.